

Next Generation Shipboard Medium Voltage DC Architecture Study



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Sponsors: Office of Naval Research, DRS Power and Control Technologies

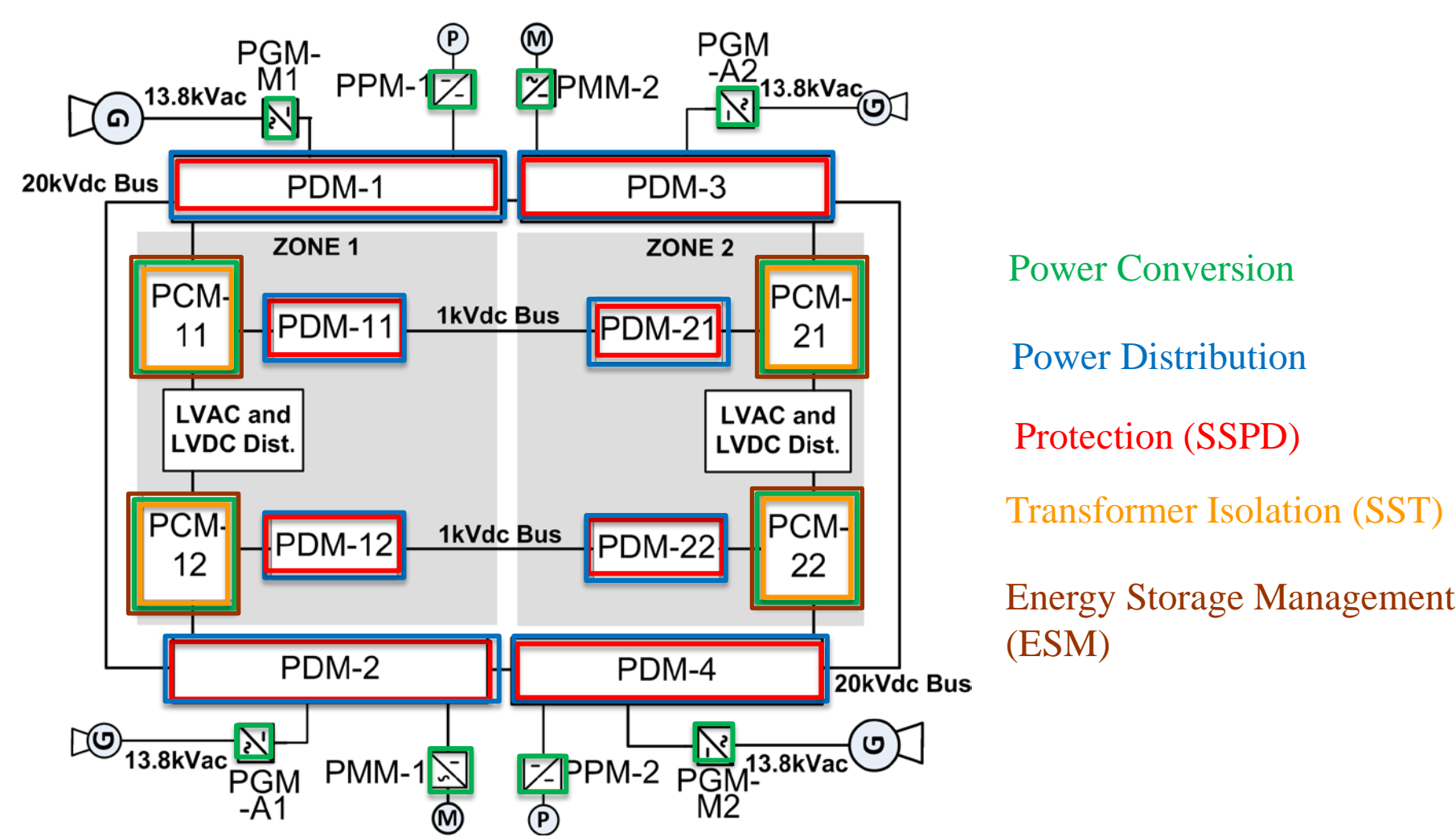
I. Introduction

Identify and Assess Medium Voltage DC (MVDC) architecture(s) that might best meet the U.S. Navy’s vision for Next Generation Integrated Power Systems (NG-IPS)

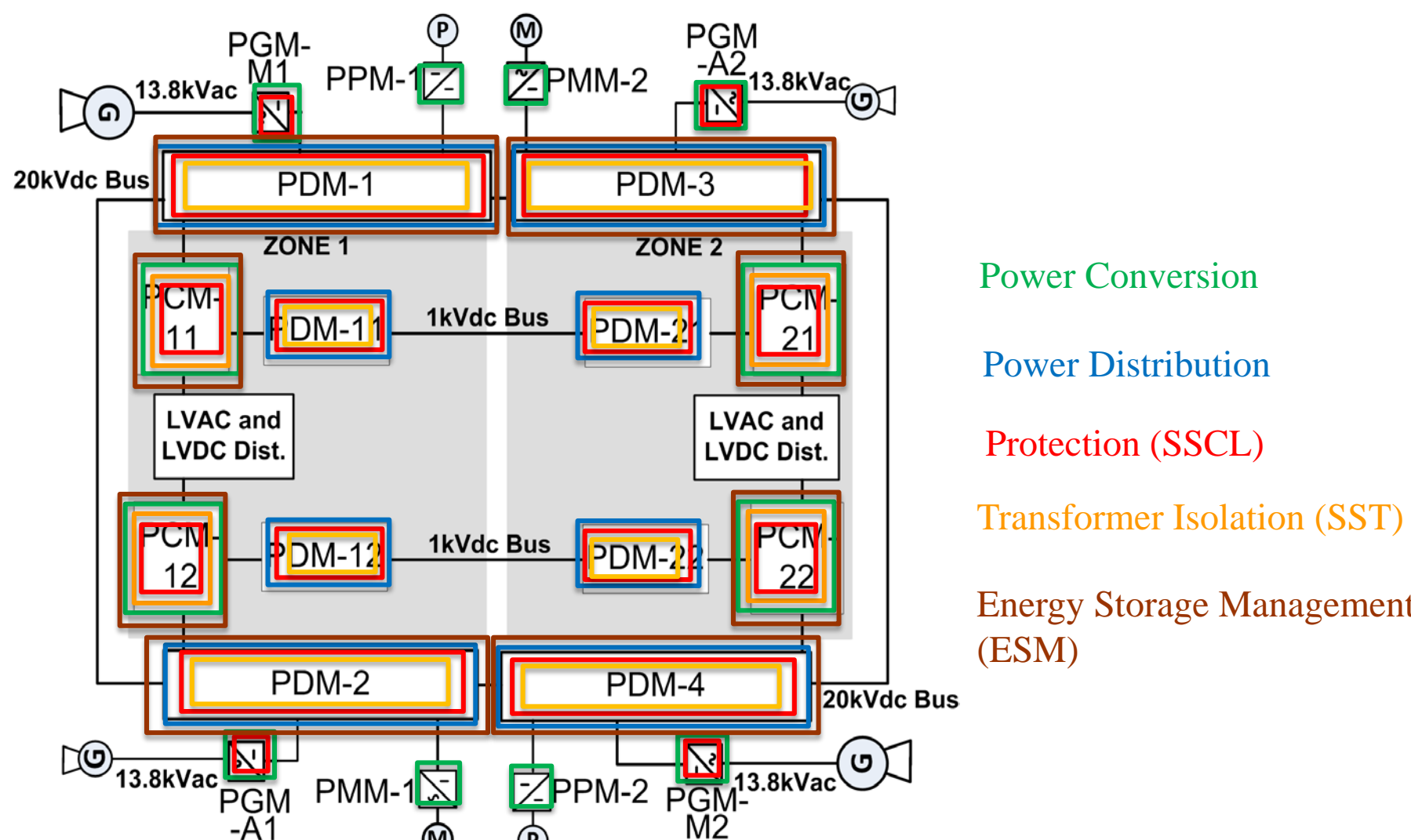
- Determine Size/Weight of Architectures
- Assess their Survivability and Reliability of Power (Quality of Service)
- Approximately 20kVdc system is assumed (based upon 13.8kVac generator feeds)
- **Emphasize line to line and line to ground short circuit fault protective strategy**
- Look at Solid State Protective Device (SSPD) topologies
- **Consider capabilities and improvements can be enabled by the use of wide bandgap power semiconductors (specifically SiC MOSFET, IGBT and SGTO)**
 - Power Conversion → You can’t get there without it
 - Protective Devices → SiC based options may be viable but current ratings don’t line up with MVDC needs
- Include Solid State Transformer (SST) interfaces between MVDC and Low Voltage (LV) system

II. “Breaker-Based” & “Breaker-Less” Systems

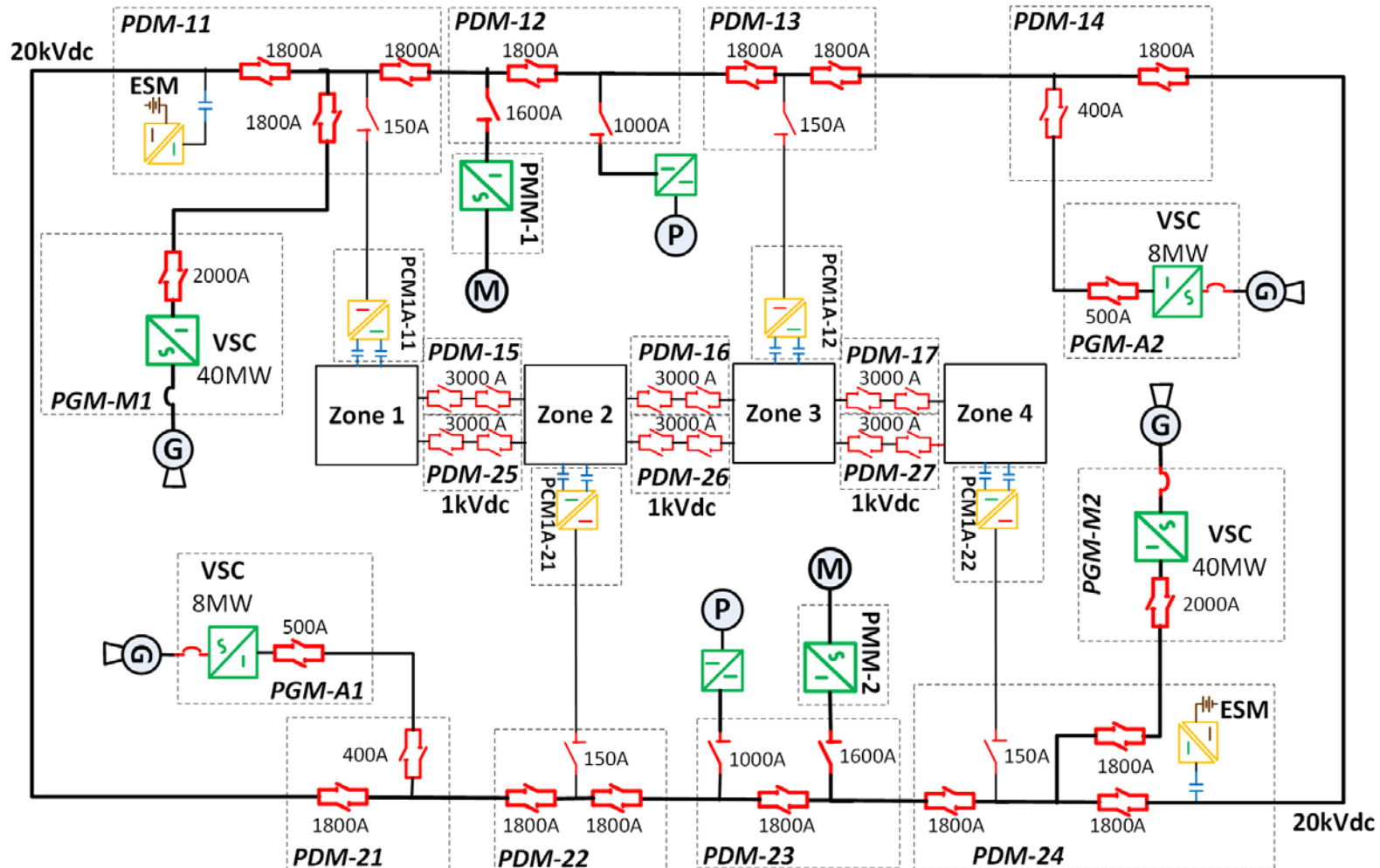
“Breaker-Based”



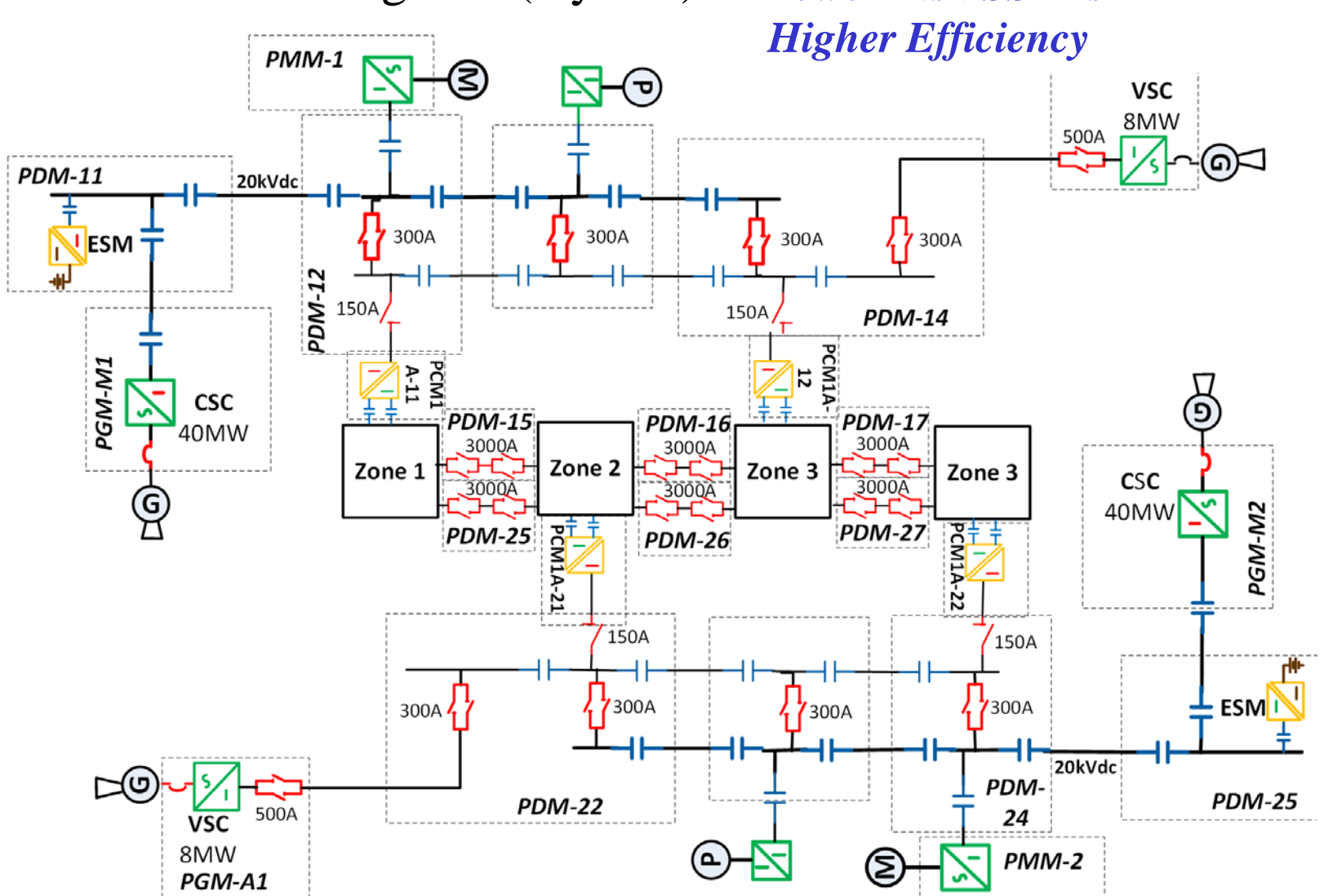
“Breaker-Less”



Dual Ring Bus (“Breaker-Based”) *High Reliability of Power High Cost*

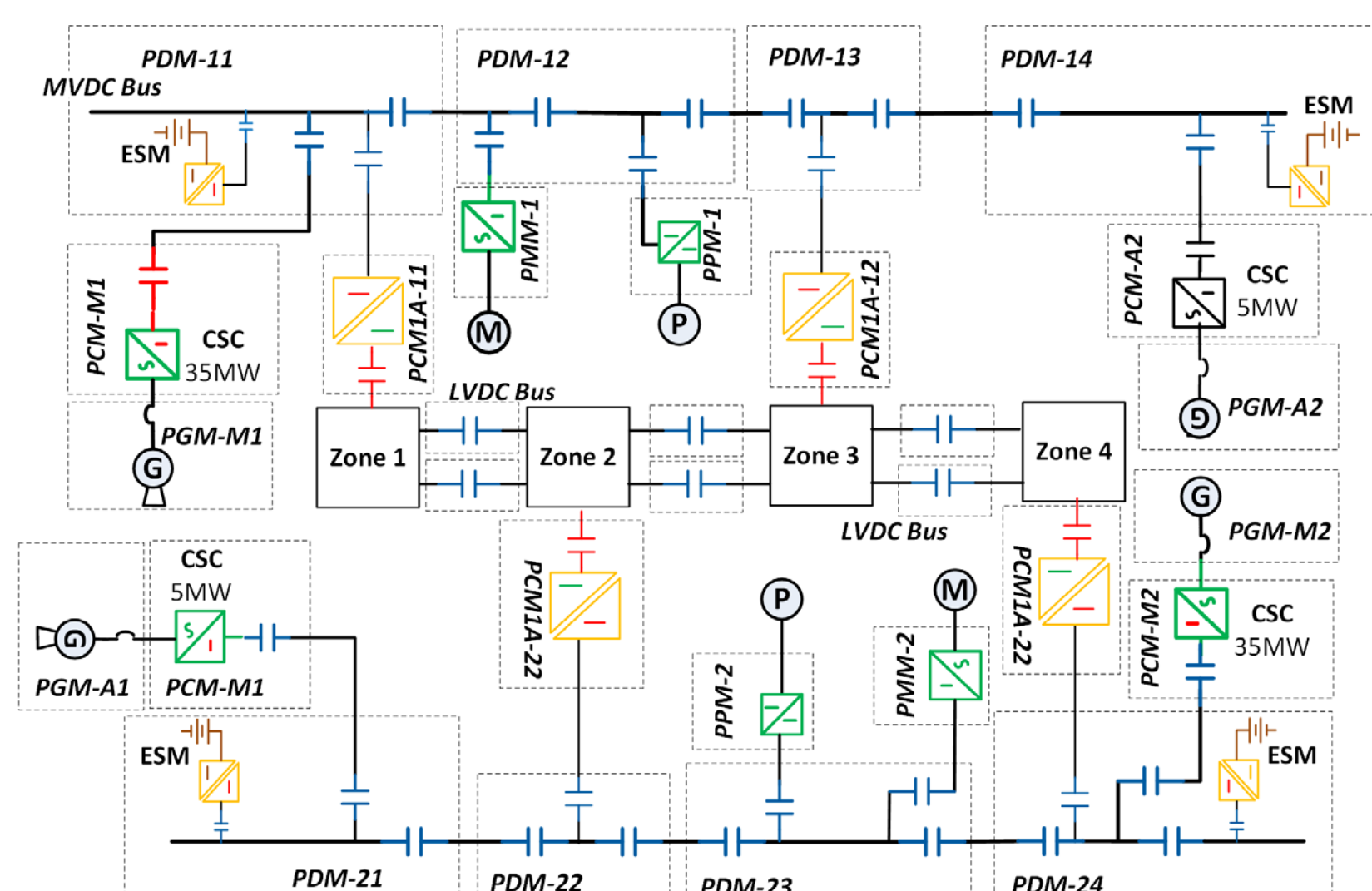


Dual MVDC Ring Bus (Hybrid)



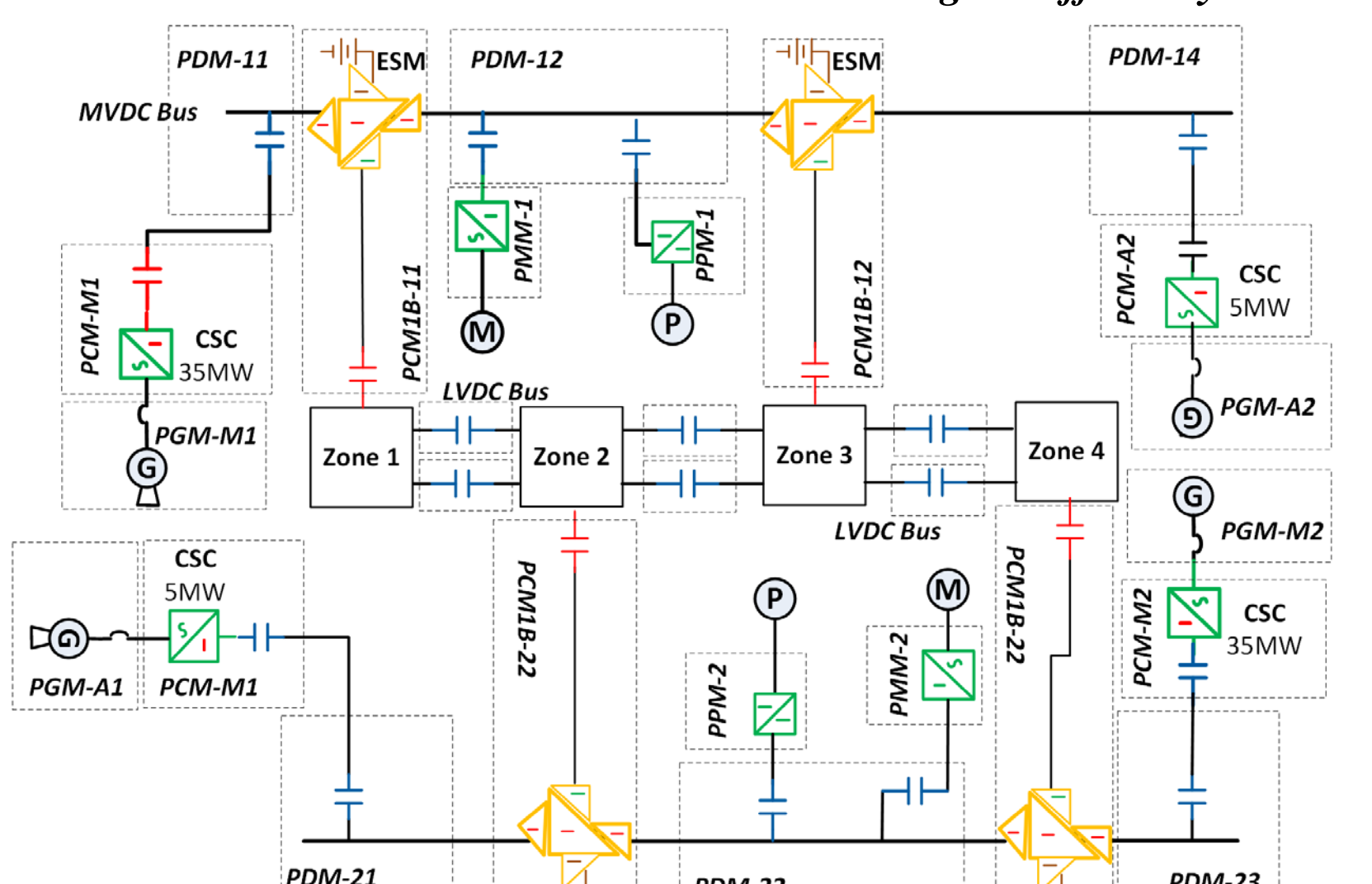
CSC Based PGM (“Breaker-Less”)

Low Reliability of Power Low Cost



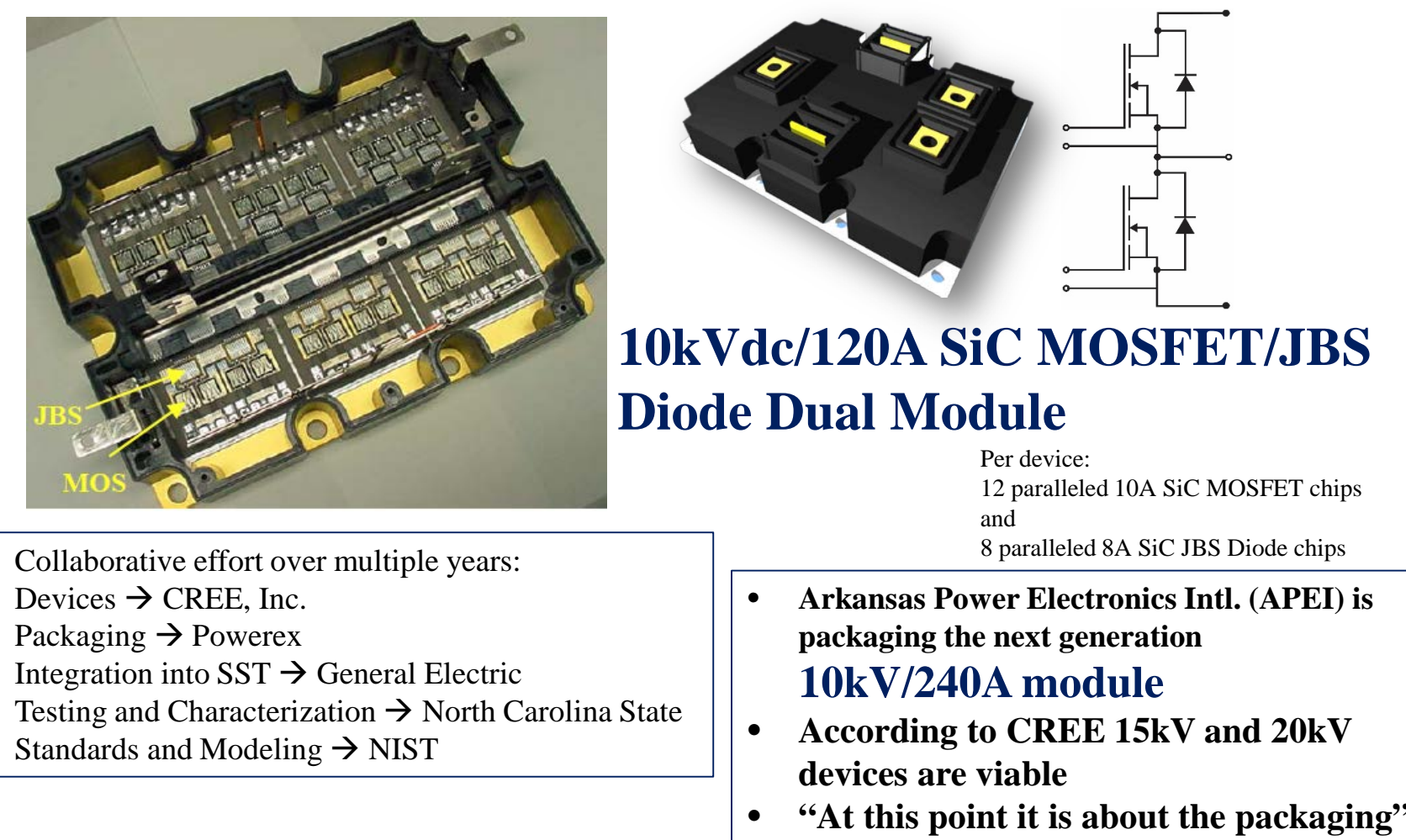
SST Isolated (“Breaker-Less”)

High Reliability of Power Low Cost? Higher Efficiency?

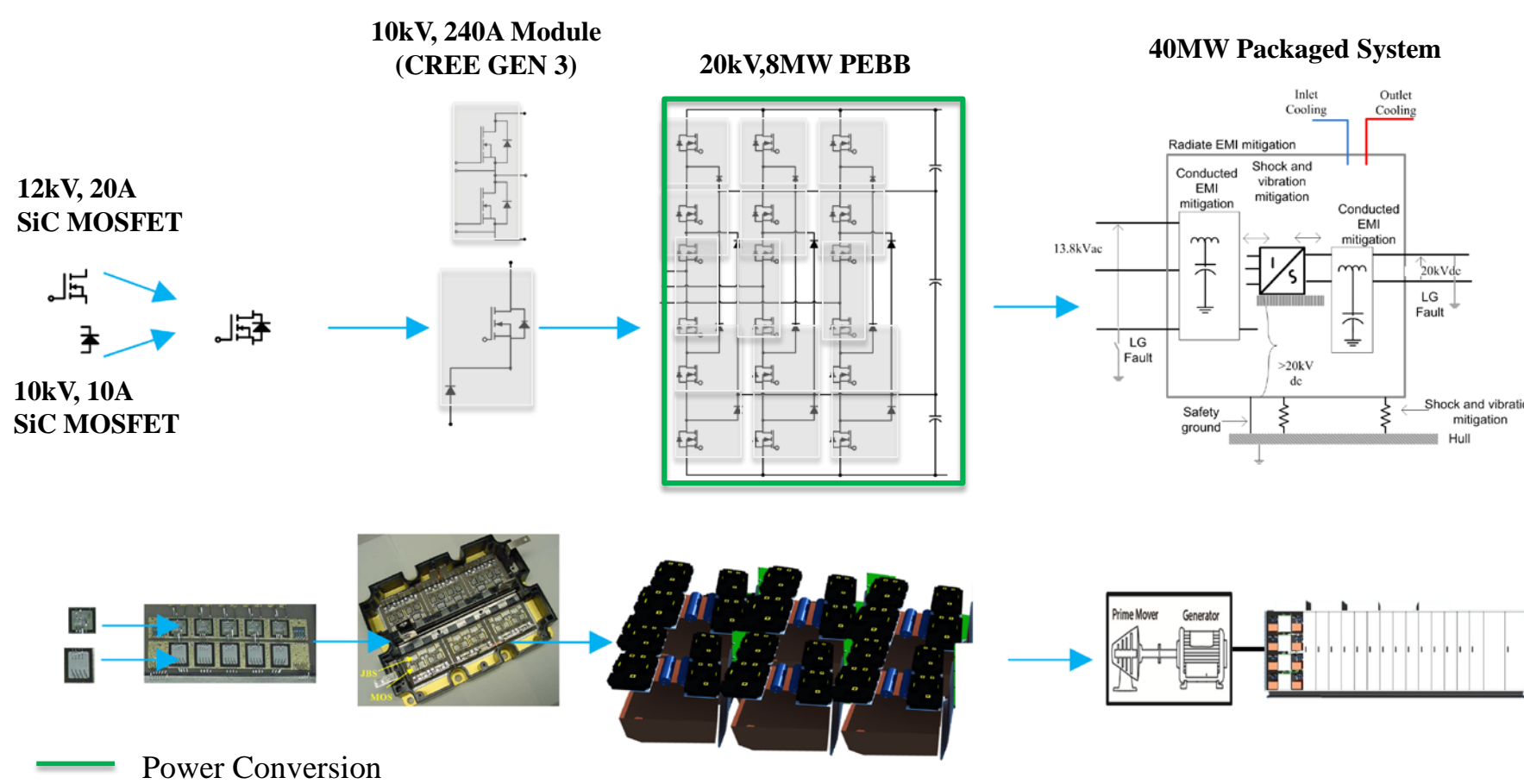


III. 10kV SiC MOSFET Module Building Blocks

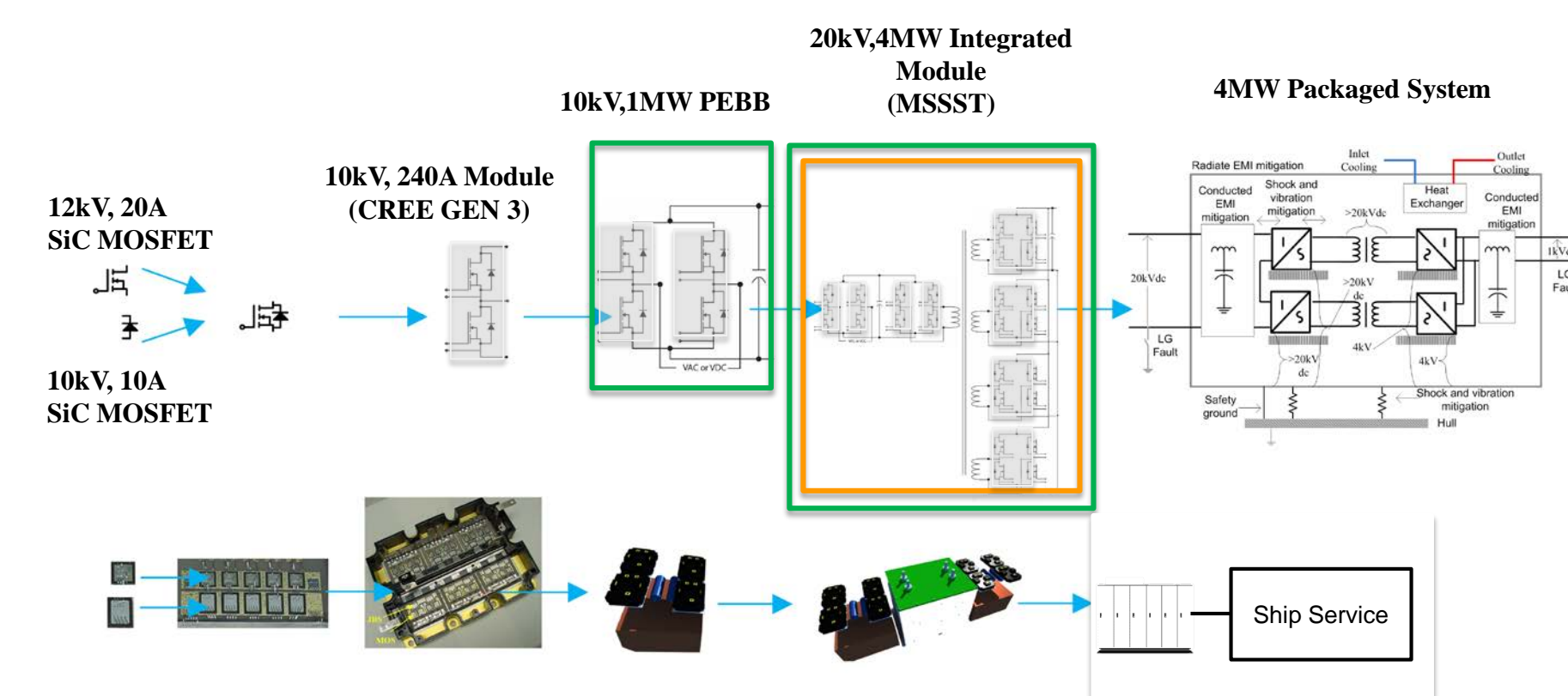
ONR SiC MOSFET Module



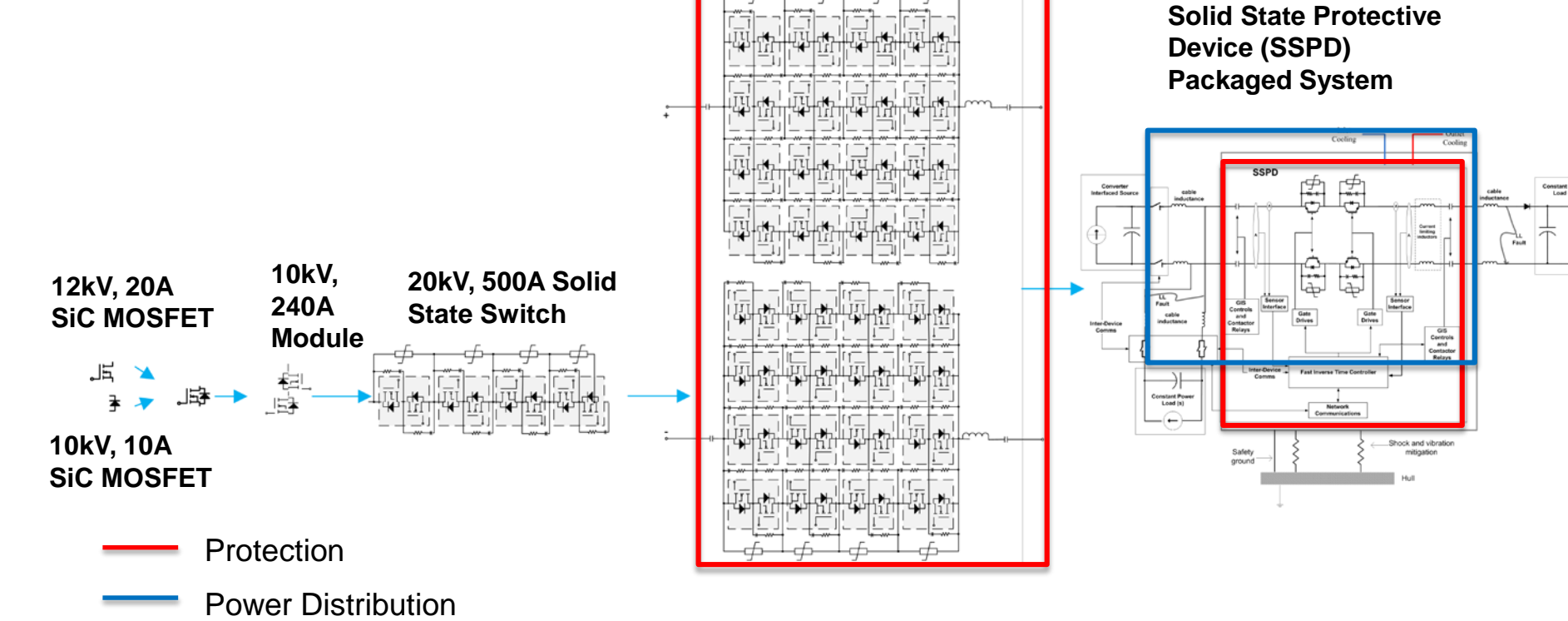
PGM PCM



PCM1A

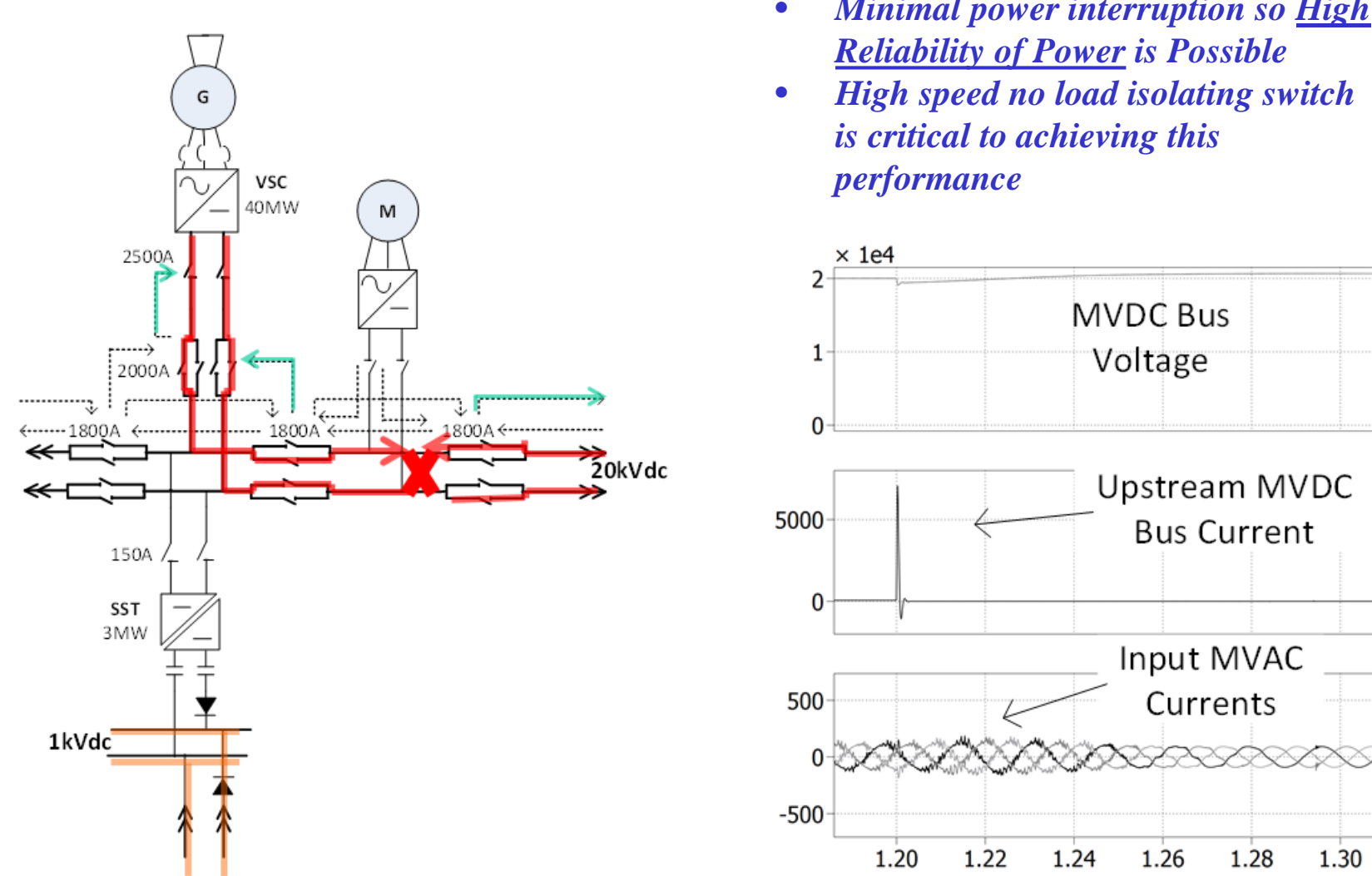


SSPD

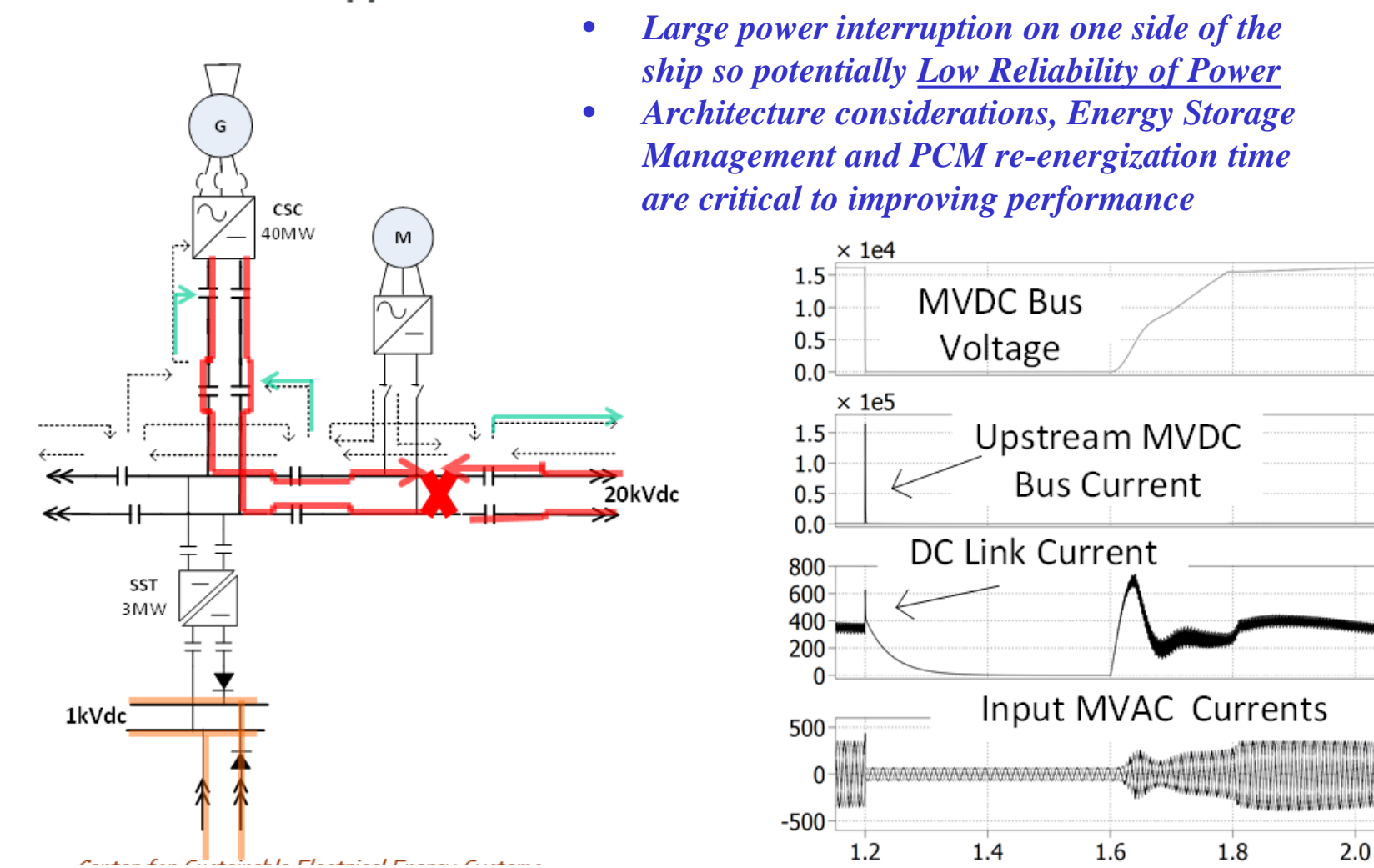


IV. Reliability of Power Assessments

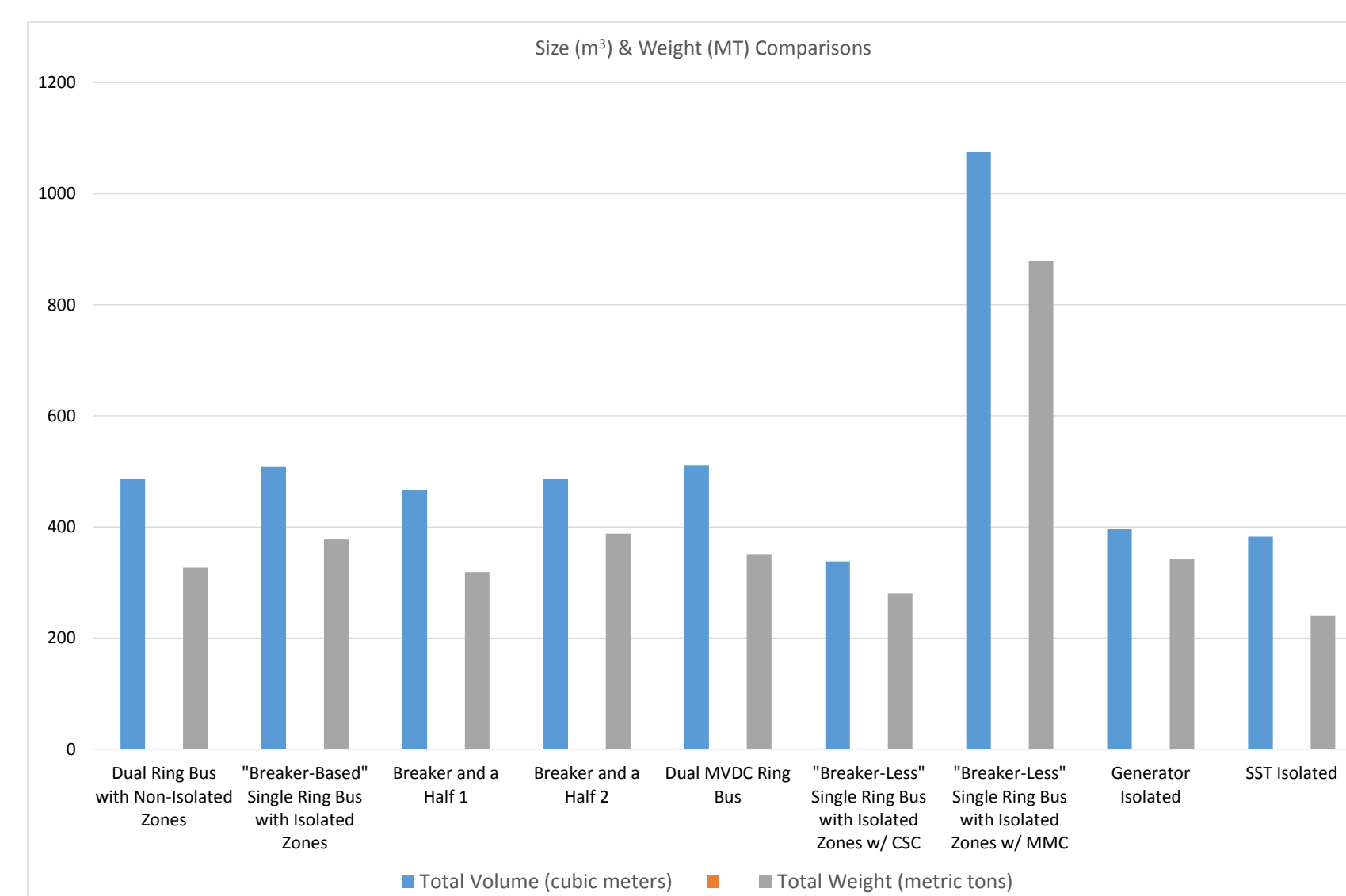
MVDC Fault Simulation Results “Breaker-Based” Approach



MVDC Fault Simulation Results “Breaker-Less” Approach



V. Size/Weight Assessments



VI. Risk Areas

- Current limitation of the SiC devices
- Multi-MW power conversion and the need to parallel multiple modules to achieve targeted power levels
- High current SSPD devices
- Technical readiness of SiC technology
 - EMI issues
 - Reliability
- Heat sink ground isolation for MVDC systems
- New component development
- SST Transformer design
 - Parasitic capacitance management
 - Thermal Management for reliability and ruggedness